# Stormwater TMDL for the Benthic Impairment in the Accotink Creek Watershed

# Assessment of the Proposed Technical Approaches

*Second Technical Advisory Meeting*
*Fairfax County Government Center*
*Fairfax, Virginia*
*August 18, 2009*

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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# Agenda

- Assessment of 2 Proposed Technical Approaches

**First Approach**

- Sediment Load Duration Curve Approach Linked to Flow Volume

**Second Approach**

- Impervious Cover Model Linked to Sediment Erosion Models and to Flow Volume

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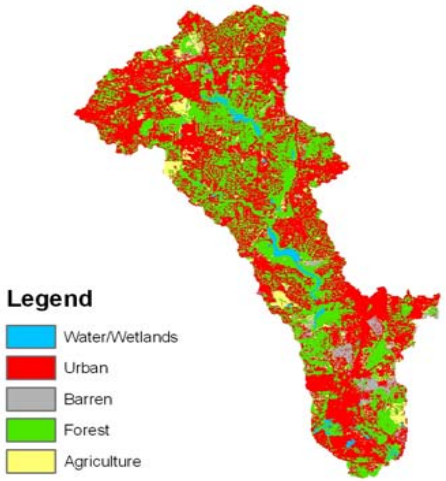
# Urbanization in Accotink Creek Watershed

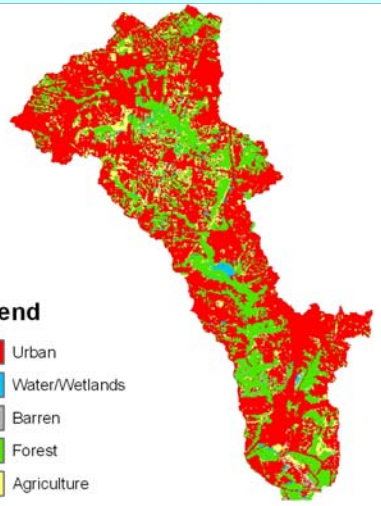



## NLCD 1992

| Land Cover Type | Acres | % of Watershed |
|---|---|---|
| Urban | 16,131 | 52.2% |
| Water/Wetlands | 615 | 2.0% |
| Barren | 959 | 3.1% |
| Forest | 11,482 | 37.2% |
| Agriculture | 1,703 | 5.5% |
| Total | 30,890 | 100.0% |

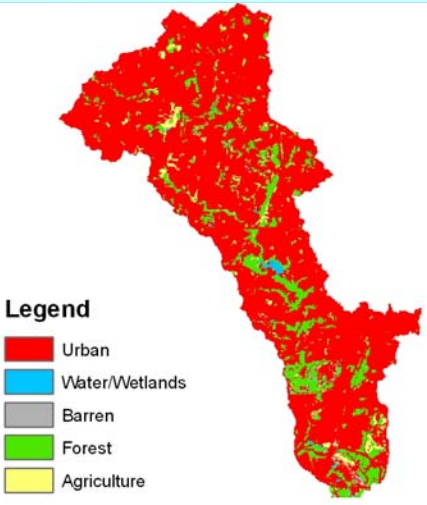
**The percent of developed area in Accotink Creek watershed has increased dramatically**

**from 52% (in 1992) to 83% (in 2005)**




## NLCD 2001

| Land Cover Type | Acres | % of Watershed |
|---|---|---|
| Urban | 19,010 | 61.5% |
| Water/Wetlands | 407 | 1.3% |
| Barren | 278 | 0.9% |
| Forest | 8,386 | 27.1% |
| Agriculture | 2,809 | 9.1% |
| Total | 30,890 | 100.0% |




## NLCD 2001 - DOF 2005 Hybrid

| Land Cover Type | Acres | % of Watershed |
|---|---|---|
| Urban | 25,708 | 83.2% |
| Water/Wetlands | 172 | 0.6% |
| Barren | 180 | 0.6% |
| Forest | 3,768 | 12.2% |
| Agriculture | 1,061 | 3.4% |
| Total | 30,890 | 100.0% |

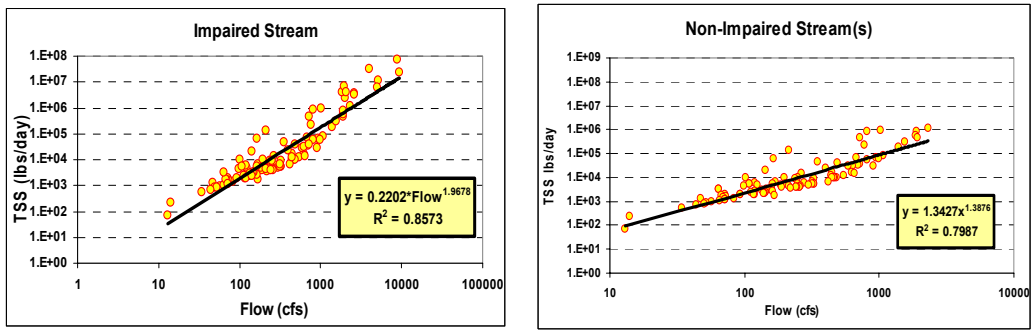
# First Approach: Sediment Load Duration Curve Approach Linked to Flow Volume

Use a widely adopted method to:

- **develop correlations between stream flow and total suspended sediment (TSS) observations in the impaired segment and non-impaired streams**

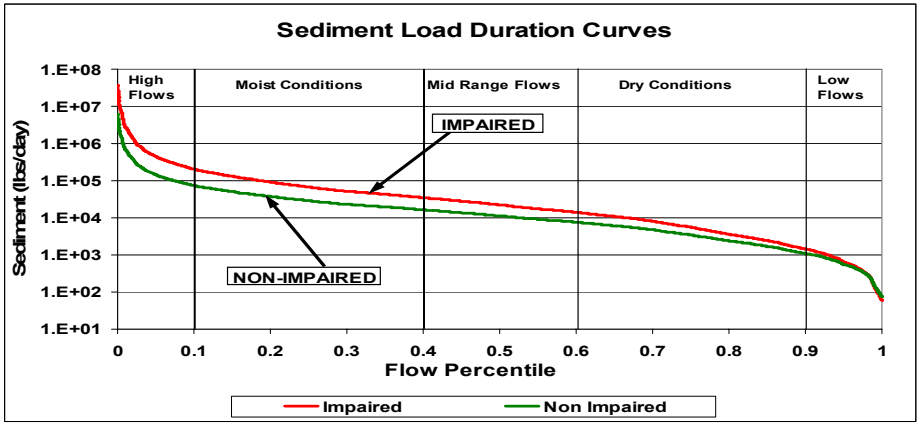
- Using these relationships, the required reduction of sediment load and stormwater volume can be determined

## Step 1




Hypothetical Sediment Rating Curves for Impaired and non-Impaired Streams

## Step 2




Hypothetical Sediment LDC for Impaired and non-Impaired Streams

## Step 3

Apply the GWLF model (land based erosion) and the Evans equation (instream erosion) to the Accotink Creek watershed

Estimate the overall simulated sediment yield and the sediment yield by source

Compare the overall simulated sediment yield with the yield from the impaired sediment load duration curve to identify the required sediment reduction

## Step 4

Use the required sediment reduction and sediment yield by source to develop the initial load allocations

Estimate the volume of stormwater and indentify the required stormwater flow reduction using the sediment ration curves or flow duration curves

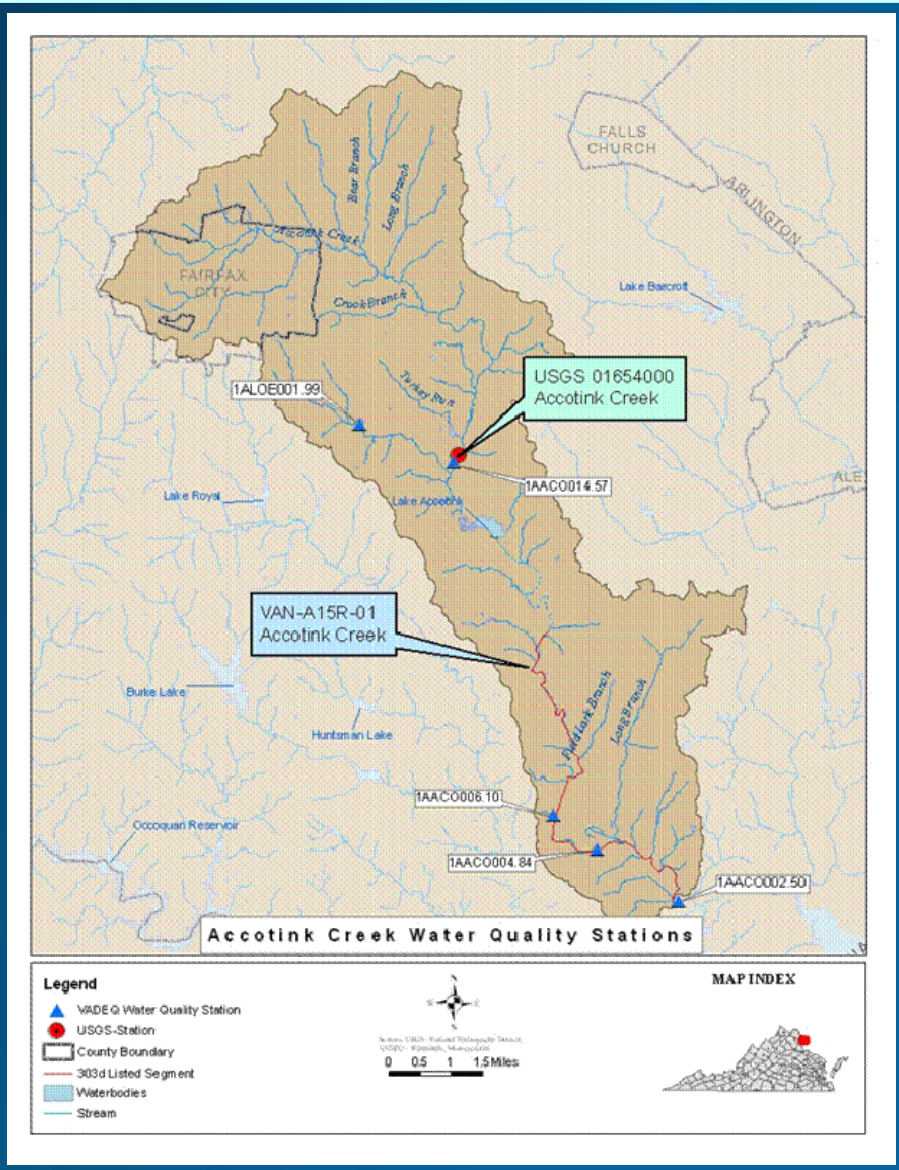
Use an area-weighted approach to allocate for the MS4s

Develop Waste Load Allocations, Develop TMDL

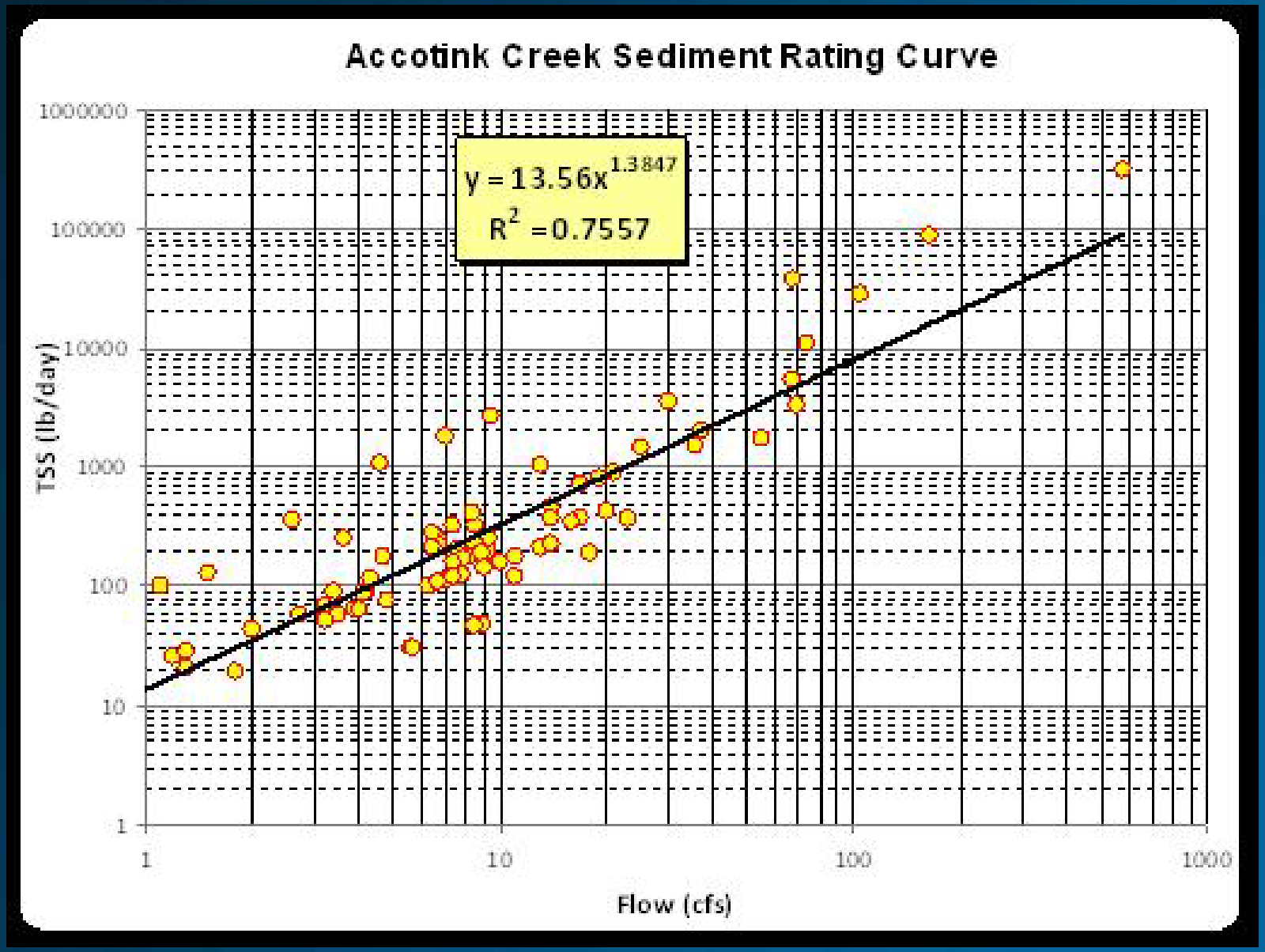
# Step 1: Develop Sediment Rating Curves

## Accotink Creek Sediment and Streamflow Data

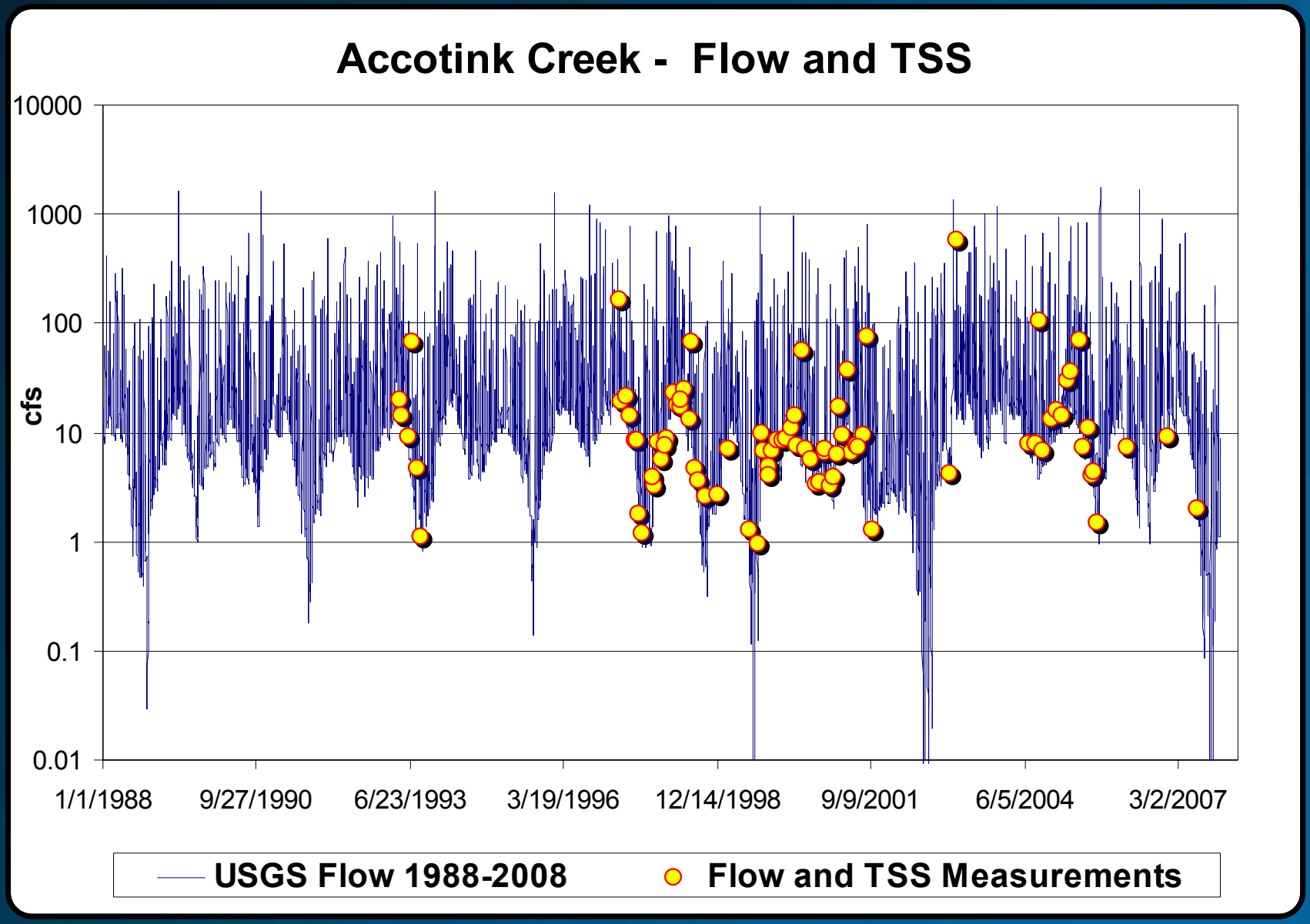
- Stream and sediment data collected concurrently at USGS Station 01654000 and VADEQ water quality station AACO014.57 are used to develop the sediment rating curve
- A total of 84 observations of sediment and flow collected concurrently and spanning the period from 1993 to 2007



# Accotink Creek Sediment Rating Curve



# Streamflow and TSS Data

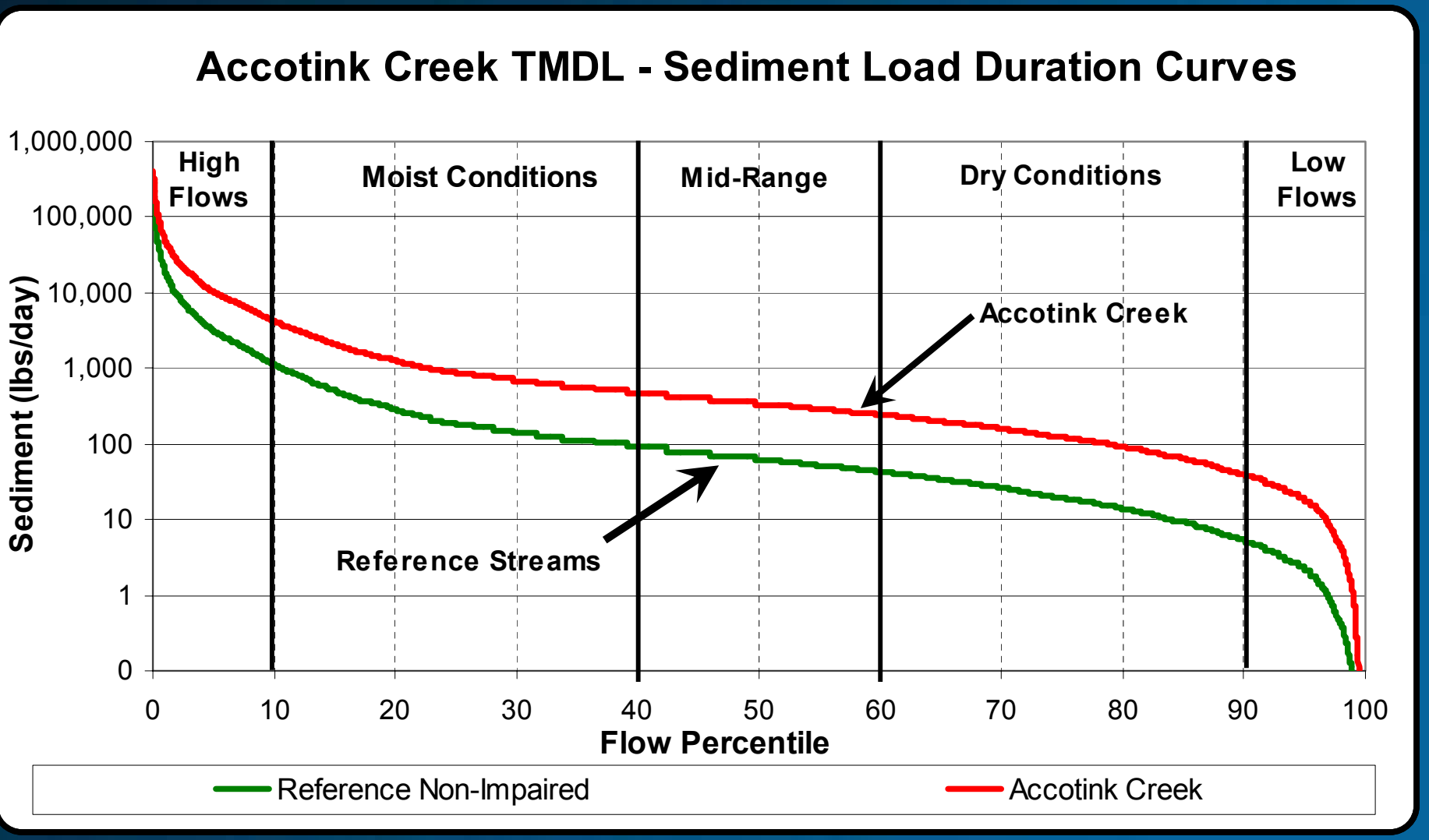


# Step 2: Develop Sediment Load Duration Curves

**Sediment LDC characterizes sediment loads at different flow regimes**

**The sediment rating curve for non-impaired streams developed for the Rivanna River Benthic TMDL (VADEQ 2008) is used for the illustration and assessment of the first TMDL approach**

# Step 2: Develop Sediment Load Duration Curves



# Draft Sediment Loads by Flow Regime

| Load (lbs/day) | Flow Regime | | | | |
|---|---|---|---|---|---|
| | High | Moist | Mid-Range | Dry | Low |
| Impaired Load Duration Curve (Existing Conditions) | 10,300 | 850 | 320 | 120 | 17 |
| Non-Impaired Load Duration Curve (TMDL) | 3,130 | 180 | 60 | 19 | 2 |
| Reduction (%) | 70 | 79 | 81 | 84 | 88 |

# Step 3: Identification of the Required Overall Sediment Reduction

**Estimate the Overall Sediment Yield and the Sediment Yield by Source**

- Estimate the Land-based Sediment Loads from Non-Urban Areas Using the Generalized Watershed Loading Functions (GWLF) Model
- Estimate the Land-based Sediment Loads from Urban Areas Using Literature Values (NALMS, NURP, EPA)
- Estimate the Sediment Loading from Instream Bank Erosion Using a Spatial Technique by Evans et al. (2003)

**Link the Estimated Overall Sediment Yield (Land-based and Instream Bank Erosion) to the Accotink Creek Sediment LDC to identify the corresponding sediment load reduction**

# Step 4: Develop Allocations

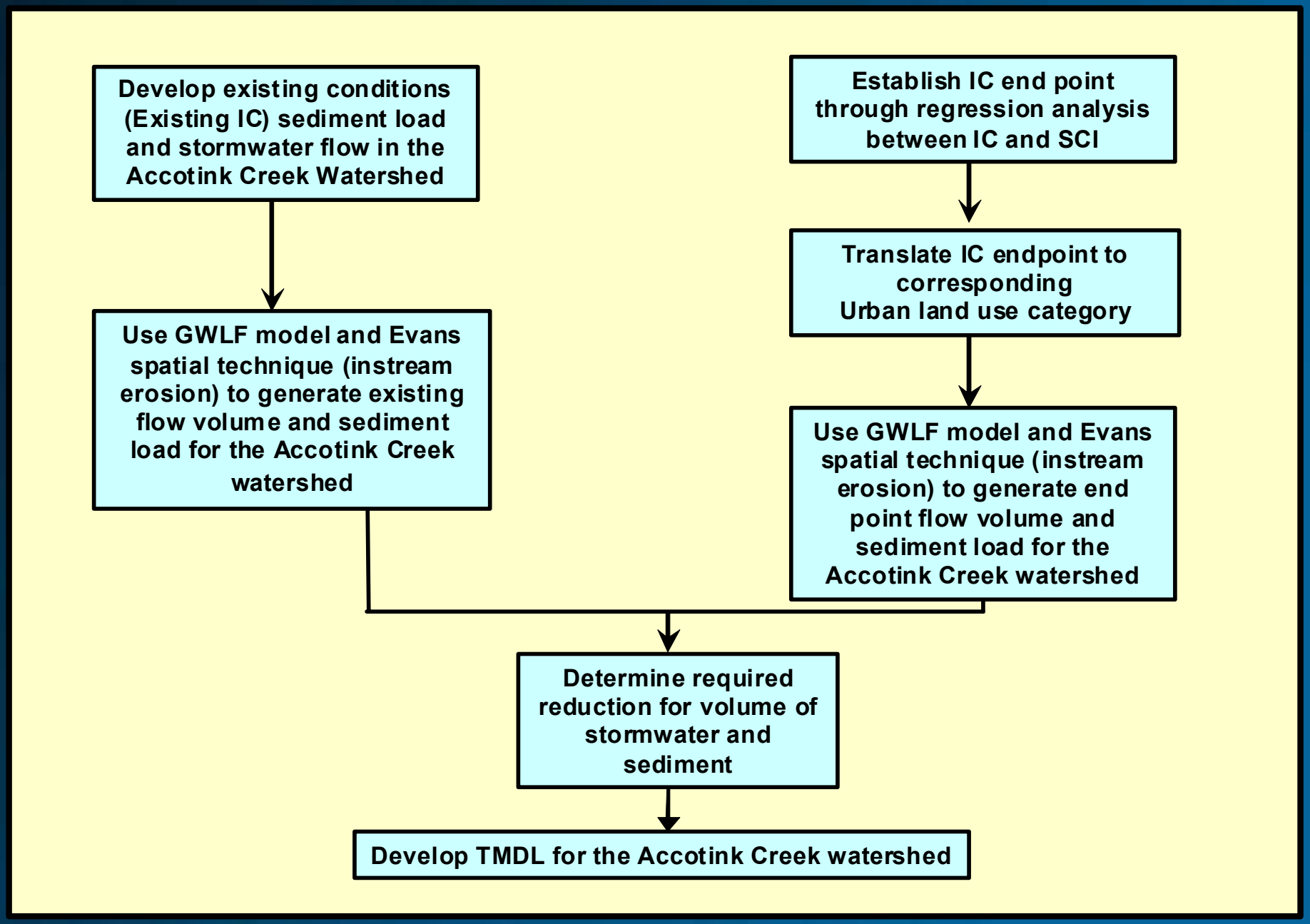
- Use the sediment load reduction and sediment yield by source to develop the initial load allocations
- Estimate the volume of stormwater and identify the required stormwater flow reduction using the sediment rating curves or flow duration curves
- Use an area-weighted approach to allocate for the MS4s
- Develop Waste Load Allocations, Develop TMDL

# Second Approach: Impervious Cover Model

- Use the impervious cover (IC) as an indicator of urban watershed degradation
- Establish a relationship between Impervious Cover (IC) and stream health
- Use this relationship to identify the IC endpoint for healthy streams
- Link the IC in Accotink Creek and the IC endpoint to sediments and stormwater flow volume

  - *The use of IC as a measure for urban watersheds degradation is not new; Over 200 Scientific Articles in the last 20 years show that IC is an excellent indicator of development impacts*

# Impervious Cover Model



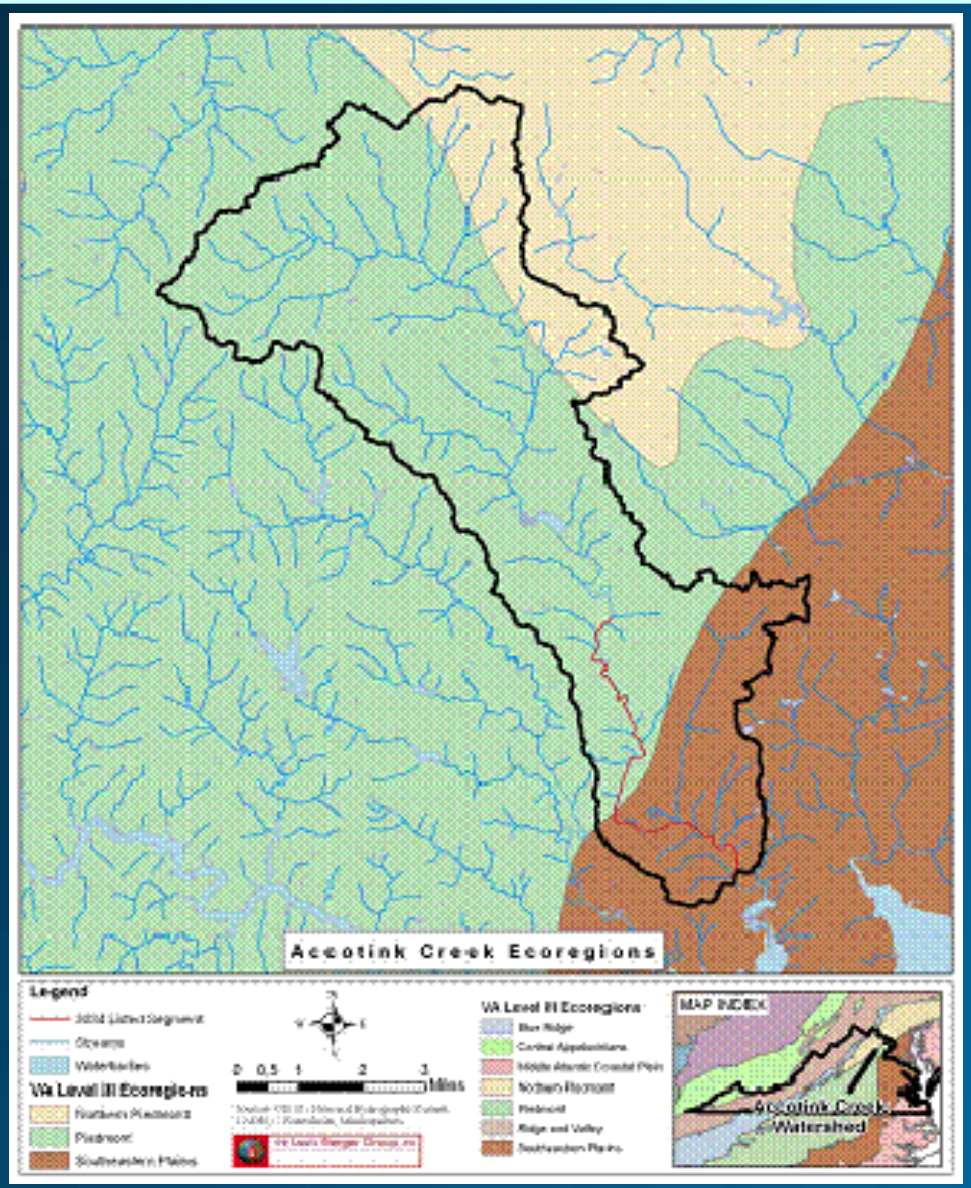
# Establish TMDL Endpoint for Impervious Cover

- Used the VADEQ statewide VSCI scores database for 2004-2008 and the DCR National Watershed Boundary Dataset (NWBD-Virginia portion)
- The 2005 Department of Forestry (DOF) land use data was then combined with the NWBD boundary layer to develop land use distributions associated with each VADEQ station included in the 2004-2008 VSCI statewide database
- For this preliminary assessment, all the stations included within a DCR-NWBD were assigned the same land use distribution

# Step 1: Establish TMDL Endpoint for Impervious Cover

- The DOF land use data was selected because it is the more recent data set that has specific classifications of urban land covers such as pavement, rooftop, and residential
- Level of impervious was calculated by assigning impervious level to each urban classification in the DOF land use data (pavement and rooftop 100% and residential 60%)
- The resulting data (level of impervious and VSCI scores) was then disaggregated by ecoregion prior to the performing the statistical analysis
- The statistical package Minitab® (Version 14) was used to develop the regressions in order to develop preliminary correlations between the VSCI score and the level of imperviousness for the stations within each Virginia Ecoregion

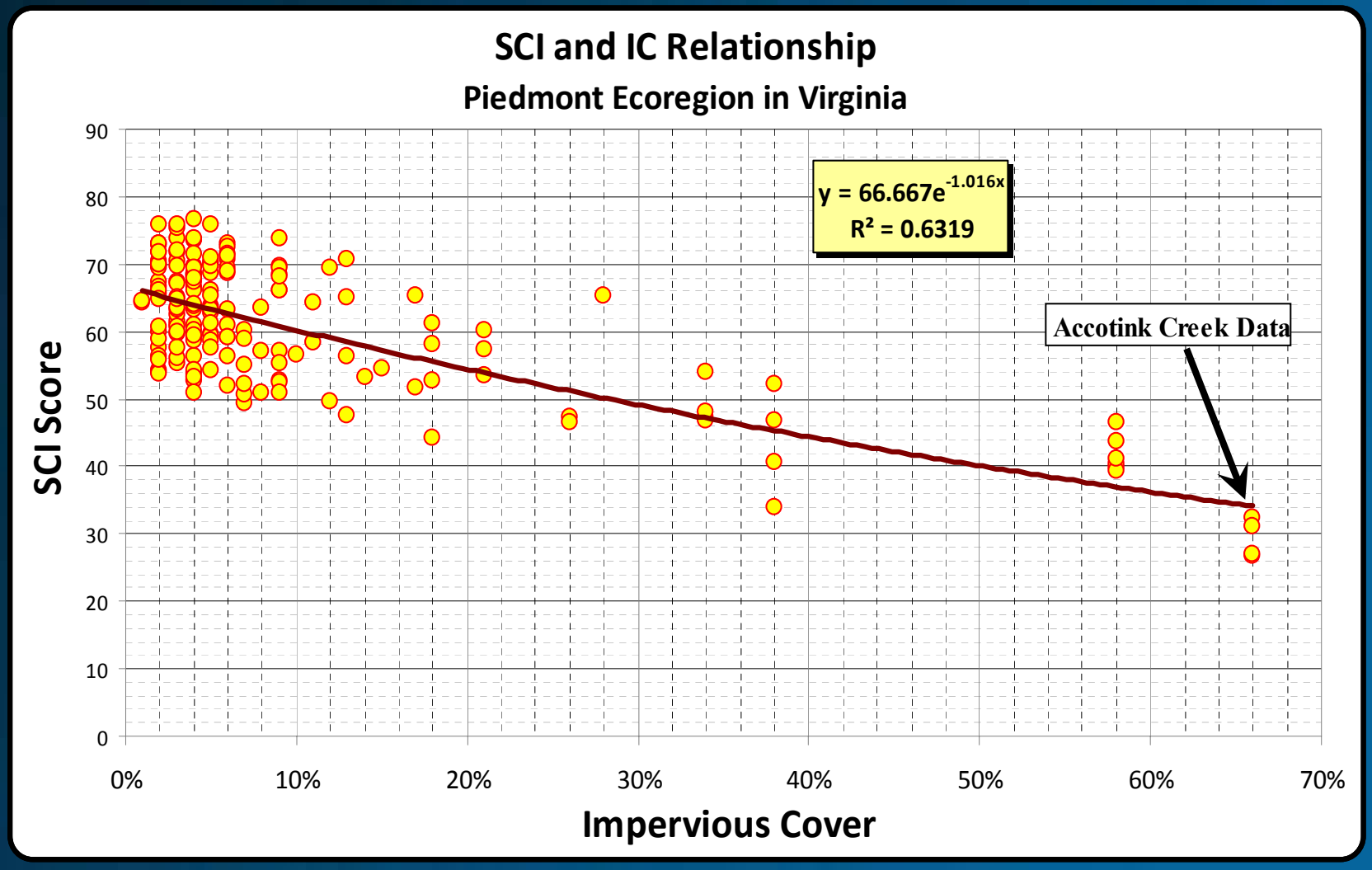
# Accotink Creek Watershed and Virginia Level III Ecoregions



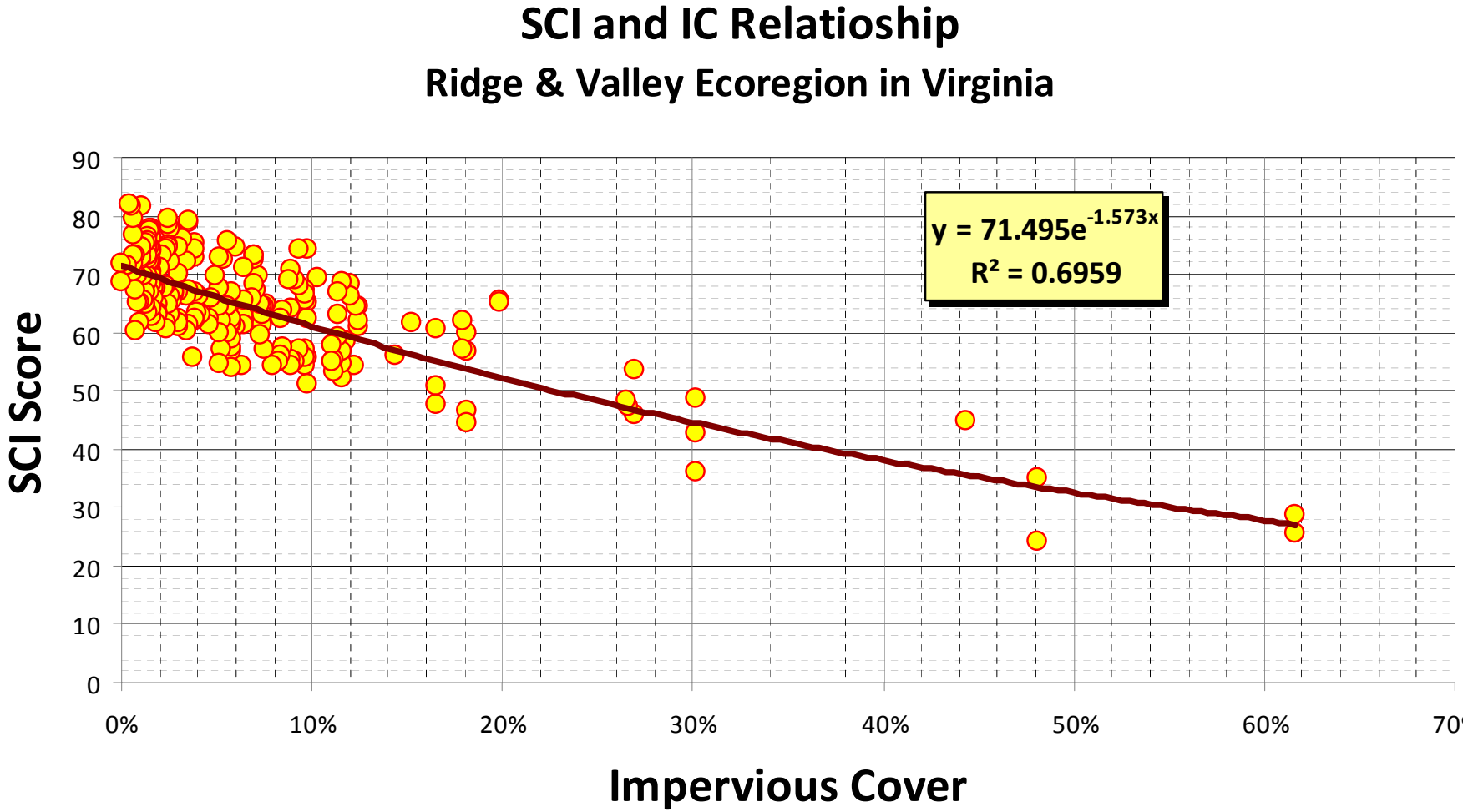
# Preliminary Results - Impervious Cover vs. SCI

| Ecoregion | Data Points | R-Square (%) | Range of Observed Values | | Resulting IC Endpoint (%) |
|---|---|---|---|---|---|
| | | | SCI | IC (%) | |
| **Blue Ridge** | 43 | **27.3** | 50.2 - 84.5 | 0.5 - 12.2 | 8.5 |
| **Central Appalachians** | 54 | **27.7** | 35.6 - 75.7 | 0.8 - 11.1 | 8.0 |
| **Middle Atlantic Coastal Plain** | 19 | **NA** | NA | NA | NA |
| **Northern Piedmont** | 98 | 49.7 | 31.8 - 78.5 | 1.0 - 82.1 | 10.5 |
| **Piedmont** | 176 | 63.2 | 26.7 – 76.7 | 1.0 – 66.0 | 10.5 |
| **Ridge and Valley** | 223 | 69.6 | 24.1 – 81.8 | 0.0 – 62.0 | 11.0 |
| **Southeastern Plains** | 64 | **3.9** | 17.6 - 78.6 | 1.2 - 78.2 | NA |

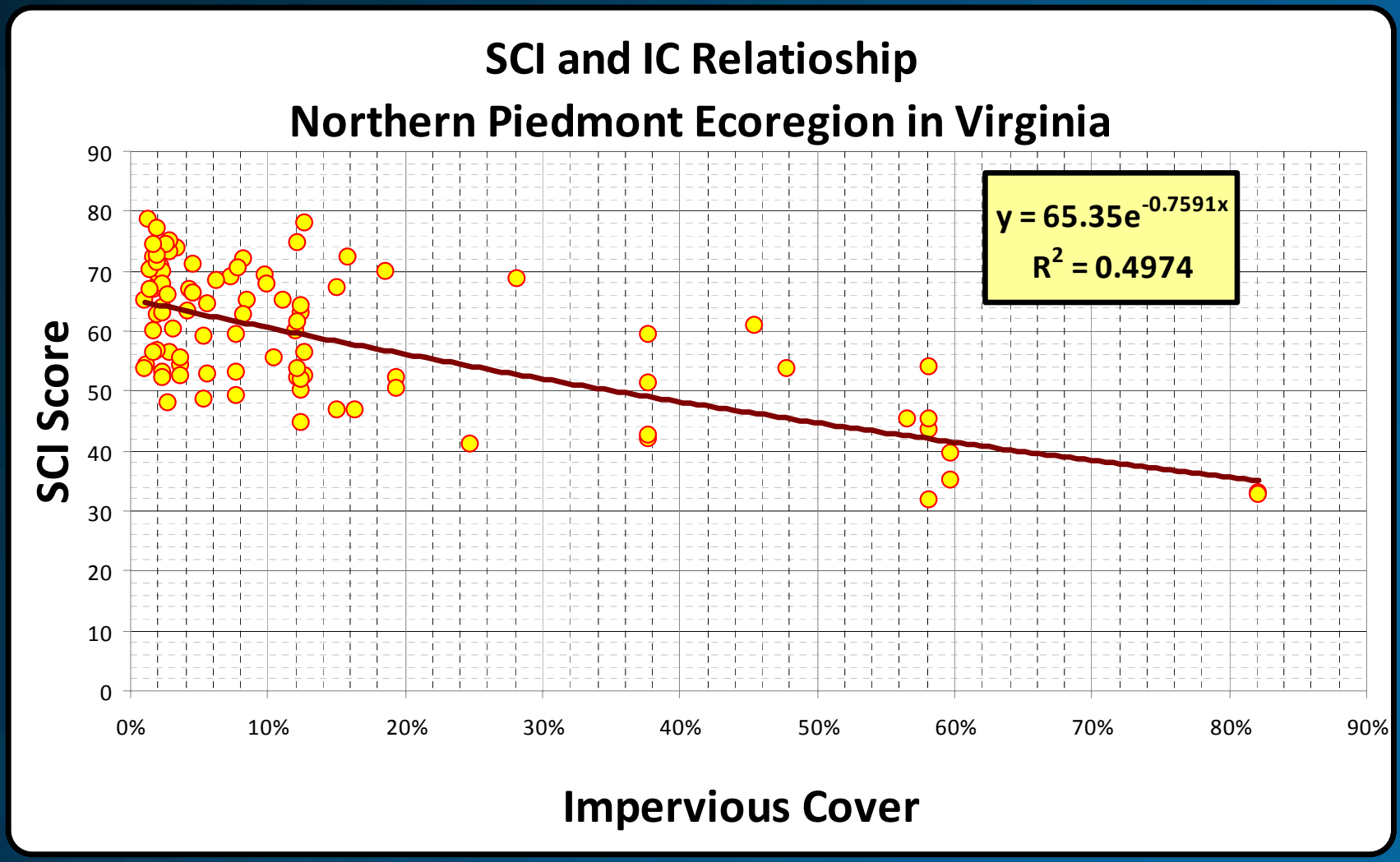
# Preliminary Result: SCI vs. IC Piedmont Ecoregion



# Preliminary Result: SCI vs. IC Ridge and Valley Ecoregion



# Preliminary Result: SCI vs. IC Northern Piedmont Ecoregion



# Impervious Cover Model

## Step 2: Estimate the Overall Sediment Yield in Accotink Creek under Existing and IC Endpoint Conditions

- Estimate the Land-based Sediment Loads from urban and non-urban areas
- Estimate the Sediment Loading from Instream Bank Erosion Using a Spatial Technique by Evans et al. (2003)
- Calculate the Required Sediment Load Reduction Based on the Difference between Existing and IC Endpoint Conditions

# Impervious Cover Model

Step 3: Identify the Required Overall Volume of Stormwater Reduction

- Establish Flow Duration Curves (FDC) for existing conditions (observed stream flow) and endpoint IC conditions (predicted flow from GWLF or using historic flow and land use data)
- Determine the required stormwater reduction based on the difference between both FDCs

# Conclusions

- Either approach can be used for the development of the benthic TMDL in Accotink Creek

- Both approaches have been used in developing similar TMDLs
- Both approaches are based on good science

- Option 2 (IC Model) can address directly stormwater flow without the link to sediments

# Next Steps

- Identify Final Approach to Use
- Finalize Endpoint Estimation
- Develop TMDL Allocations
- Plan for TAC and Public Meetings
- Draft TMDL Report

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